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Mycale (*Aegogropila*) *magellanica* (Porifera: Demospongiae) in the southwestern Atlantic Ocean: endobiotic fauna and new distributional information

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SUMMARY: The composition of endobionts in the sponge *Mycale* (*Aegogropila*) *magellanica* at the shelf-break, near 100 m depth, in the Argentine Sea was studied. We also provide new information on the distribution of *M.* (*A.*) *magellanica,* extending its northern limit to 38º36.02'S and 55º44.68'W, 91 m in the SW Atlantic Ocean. The main Patagonian scallop fishing grounds are located in the shelf-break frontal area of the Argentine Sea. In this area, *M.* (*A.*) *magellanica* plays an important role in providing habitat for at least 23 taxa of small invertebrates, mostly crustaceans (66% to 96% of the total number of individuals). On average, this sponge hosted 348 individuals per litre; *Aristias* cf. *antarcticus* (Amphipoda) was the most frequent and abundant species. Other organisms commonly found were the isopod *Caecognathia* sp., the amphipod *Leucothoe* cf. *spinicarpa*, the bivalve *Hiatella meridionalis* and the ophiuroid *Ophiactis asperula*. As previously demonstrated for other sponges, our study suggests that *M.* (*A.*) *magellanica* enhances benthic biodiversity, as it shelters a variety of invertebrate species. In areas of soft and flat substrate, erect and sessile epifauna usually acts as an ecosystem engineer, structuring the architecture of the habitat by increasing the sea-bottom complexity. Mass removal of this fauna due to intense trawling activities on Patagonian scallop beds could have devastating effects on local biodiversity.

Keywords: *Mycale* (*Aegogropila*) *magellanica*, sponge-invertebrate associations, benthic richness, Argentine Sea.

RESUMEN: *MYCALE* (*AEGOGROPILA*) *MAGELLANICA* (PORIFERA: DEMOSPONGIAE) EN EL ATLÁNTICO SUROESTE: FAUNA ENDOBIÓTICA Y NUEVOS DATOS DE SU DISTRIBUCIÓN. – Se estudió la composición de endobiontes de la esponja *Mycale* (*Aegogropila*) *magellanica*, recolectada en el área del talud del Mar Argentino, a una profundidad promedio de 100 m. Se presenta también nueva información sobre la distribución de *M.* (*A.*) *magellanica*, extendiendo su límite norte hasta los 38º36.02'S y 55º44.68'W, 91 m en el Atlántico Sudoccidental. En el Mar Argentino, los principales bancos de vieira patagónica están situados en el borde externo de la plataforma, en el área frontal del talud. En esta región, *M.* (*A.*) *magellanica* juega un papel importante al proveer hábitat para al menos 23 taxones de invertebrados pequeños, en su mayoría crustáceos (66 al 96% del total de individuos). En promedio, esta esponja alberga 348 individuos por litro de esponja, siendo *Aristias* cf. *antarcticus* (Amphipoda) la especie más frecuente y abundante. Otros organismos hallados con frecuencia fueron el isópodo *Caecognathia* sp., el anfípodo *Leucothoe* cf. *spinicarpa*, el bivalvo *Hiatella meridionalis* y la ofiura *Ophiactis asperula*. Tal como se ha encontrado en otras esponjas, nuestros resultados sugieren que *M.* (*A.*) *magellanica* enriquece la biodiversidad local al proveer refugio a una gran variedad de invertebrados bentónicos. En áreas de sustrato blando, la epifauna eréctil y sésil estructura la arquitectura del hábitat, aumentando la complejidad del fondo. La extracción de esta fauna a causa de una intensa actividad pesquera en los bancos de la vieira patagónica tendría efectos perjudiciales sobre la biodiversidad local.

Palabras clave: *Mycale* (*Aegogropila*) *magellanica*, asociaciones esponja-invertebrados, riqueza bentónica, Mar Argentino.

INTRODUCTION

The sponge *Mycale* (*Aegogropila*) *magellanica* (Ridley, 1881) is distributed in Antarctic, sub-Antarctic, Chilean and Argentine waters (van Soest *et al.* 2011). In this last region, *M.* (*A.*) *magellanica* is one of the most widely distributed, 39º10'S and 56º20'W being its northern distribution limit in the Atlantic (López Gappa and Landoni 2005) (Fig. 1). In spite of its wide distribution, relatively frequent finding and easy identification compared with other sponges in the shelf-break frontal area of Argentina (Schejter *et al.* 2006, Bertolino *et al.* 2007), no studies have been performed on this species, besides the original description and subsequent faunistic records.

The relation between sponges and their associated organisms ranges from accidental or intentional commensalism to predation, mutualism or parasitism (Sará and Vacelet 1973, Pawlik 1983, Wendt *et al.* 1985, Wulff 2006, Winfield and Ortiz 2010, and references therein). Endobiotic taxa registered worldwide comprise representatives of up to 11 phyla (Rützler 1976). The most common endobionts are protozoans, diatoms, cnidarians, polychaetes, crustaceans, echinoderms and other invertebrates such as pycnogonids, platyhelminths, sipunculids and nemertins, but they also include fishes (see Supplementary material Appendix 1 for examples; and Wulff 2006 for review). Klitgaard (1995) suggested that the majority of the fauna associated with sponges in temperate/cold waters is composed of facultative inhabitants, while those of the warm tropical waters are apparently obligate sponge associates. Endobionts obtain refuge, direct or indirect sources of food and sites for reproduction, while they may contribute to host defence against predators or sediment removal (Wendt *et al.* 1985, Saffo 1992, Thiel 2000, Poore *et al.* 2000, Wulff 2006).

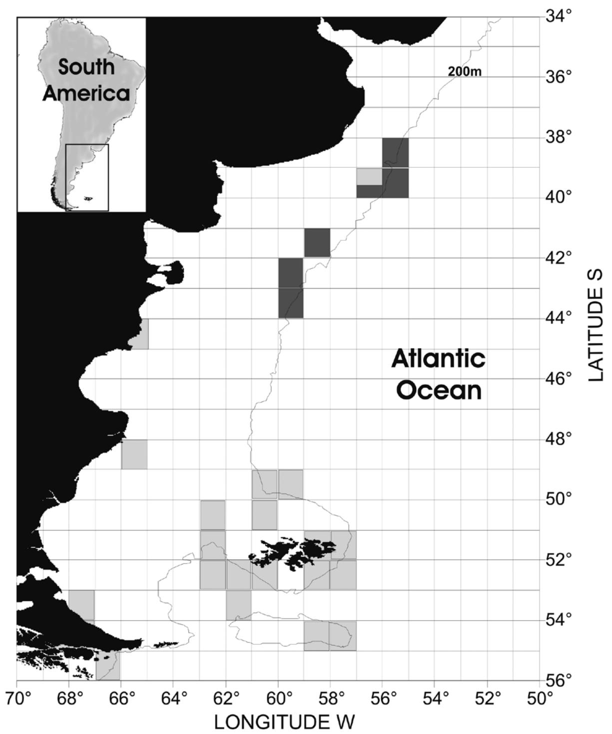

Fig. 1. – Distribution of *Mycale* (*A.*) *magellanica* (Ridley, 1881) in the Argentine Sea. Light shadow areas represent previous records, dark shadow areas represent sampling sites of the present study.

The kind of endobionts hosted by a species is related to the morphology and the chemical defence of the host sponge (e.g. Neves and Omena 2003, Skilleter *et al.* 2005), among other biotic interactions (e.g. Koukouras *et al.* 1992). Rützler (1976) found a positive relation of the sponge canal volume to total mass of endofauna, but many other studies showed no relationship between abundances of endobionts and volume of the sponge (Koukouras *et al.* 1985, Ota *et al.* 2008), presumably due to the high variability in associated endobiont fauna among sponge samples.

The total endofauna of some sponges from the North Atlantic, Mediterranean, East and West Pacific and Antarctic waters has been studied, but only a few SW Atlantic species have been studied to date: *Hymeniacidon sanguinea* (Grant, 1827) (Cuartas and Excoffon 1993), *Mycale* (*Zygomycale*) *angulosa* (Duchassaing and Michelotti, 1864) (as *Z. parishii*) (Duarte and Nalesso 1996) and *Mycale* (*Carmia*) *microsigmatosa* Arndt, 1927 (Ribeiro *et al.* 2003). However, several other, less comprehensive studies have reported sponge associates worldwide (Supplementary material Appendix 1).

López Gappa and Landoni (2005) reported the presence of 196 species in the Argentine Sea; the sponge-invertebrate associations of many of these species have not been studied yet. In this paper we studied the endobiotic fauna of *Mycale* (*A.*) *magellanica* and we compared these results with those of other sponge species. We discuss our findings in relation to the well-known benthic richness of the study area. Additional records for the distribution of the sponge *M.* (*A.*) *magellanica* in the shelf-break frontal area of the Argentine Sea are also given.

MATERIALS AND METHODS

Samples for ecological purposes (more than 100 samples consisting of a 10-litre volume each) are collected as a routine procedure during Patagonian scallop *Zygochlamys patagonica* stock assessment cruises performed yearly by the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP). These evaluation cruises are carried out in the shelf-break frontal area of Argentina, SW Atlantic Ocean, a region that supports the scallop fishery. General samplings during the assessment consist of 10-minute trawling or dredging (depending on the vessel) tows (1 tow per site) at a speed ranging between 3.5 and 4 knots. As a standard procedure, scallop stock assessment samples are processed on-board while ecological samples are frozen and then sorted at the INIDEP laboratory. The

Table 1. – Location of the sampling sites of *Mycale* (*Aegogropila*) *magellanica* (Ridley, 1881). * Samples used for endofauna composition; # Northernmost record of the species.

Sample Nº	Latitude (S)	Longitude (W)	Depth (m)	Date	Cruise Code
1	43º25.00'	59º48.78'	105	July 2004	cc1104 - L62
2	39º40.52'	56º12.28'	90	July 2007	cc0507 - L43
3	41º41.96'	58º03.10'	97	July 2007	cc0507 - L7
4	39º00.54'	55º41.82'	117	August 2004	cc1304 - L35
5 #	38º36.02'	55º44.68'	91	August 2004	cc1304 - L69
6	43º25.00'	59º49.78'	105	July 2004	cc1104 - L62
7	38º50.00'	55º35.83'	117	July 2002	cc1002 - L47
8	38º50.00'	55º35.83'	117	July 2002	cc1002 - L47
9	39º35.16'	56º01.22'	105	June 2003	cc0203 - L2
10	42º20.10'	59º04.28'	94	June 2003	cc0203 - L60
11 *	39º43.47'	56º06.55'	105	July 2009	cc1009 - L1
12 *	39º43.47'	56º06.55'	105	July 2009	cc1009 - L1
13 *	39º43.47'	56º06.55'	105	July 2009	cc1009 - L1
14 *	41º50.15'	58º08.34'	106	July 2008	MT0108 - L64
15 *	41º51.48'	58º09.89'	103	July 2008	MT0108 - L63
16 *	39º24.72'	55º56.95'	107	July 2009	cc1009 - L6

majority of the invertebrate species are identified to specific level during the analysis of the ecological samples in the laboratory. However, considering that the identification of groups such as ascidians, sponges and bryozoans is very difficult and time consuming, these organisms are usually grouped into single major taxa for the community assessment purposes (e.g. Schejter and Bremec, 2007b). Samples or vouchers of these organisms are often preserved for taxonomic and/or ecological studies. Sponges, particularly, could represent a variable percentage of the community that averaged 10% in biomass (Bremec and Lasta, 2002). When their contribution in biomass to the total community is considered relevant (although in relative terms), we keep vouchers or sub-samples of the morphospecies for subsequent analysis.

In relation to the objectives of the present study, while sorting ecological samples, we selected *Mycale (A.) magellanica* specimens from benthic community samples collected at 12 sites (localities are given in Table 1) where a conspicuous biomass of sponges was registered. Owing to the sampling methods with trawls and dredges, organisms are frequently collected broken or damaged. In consequence, the selection of these 12 samples does not mean that *M. magellanica* was absent at the other sampled sites, although the species remained unidentified during routine sorting. The biggest sponge pieces collected were separated and dissected for the current study: six sponge pieces between 340 and 660 g wet weight totalling 2.7 kg, from four localities between 39º24'S-41º51'S and 55º56'W-58º09'W and between 103 and 107 m depth. Each sponge piece was first weighed (wet weight) and the volume was determined by water displacement. Then, the sponge piece was cut, disaggregated and examined under a binocular microscope at the Benthos Laboratory (INIDEP). All the endobionts found inside the sponge were sorted, counted and identified to the lowest taxonomic level possible.

Identification of the sponge species was done using the classical procedure based on spicules and skeleton architecture observations, according to Rützler (1978). Scanning electron microscope (SEM) was also used for the observation of spicule morphology.

RESULTS

The studied specimens of *Mycale* (*A.*) *magellanica* were characterized by a massive or nearly tubular subcylindrical shape, sometimes attached to *Zygochlamys patagonica* old shells, presumably the original settlement substrate in many cases (Fig. 2A). Sizes of the different types of spicules were quite constant among specimens: i) mycalostyles, straight or slightly curved, 410 to 632 μm long (mean: 521 μm) and 10 μm thick (Fig. 2D); ii) anisochelae, three size categories (Fig. 2E): large anisochelae 62.5 to 80 μm long (mean: 71.25 μm) (rare or uncommon in some specimens), intermediate ones 32.5 to 46 μm long (mean: 24.75 μm), and small ones 20 to 30.6 μm long (mean: 25.3 μm); and iii) microxea 47.5 to 76.5 μm long (mean: 62 μm) (Fig. 2F) (measurement values were based on approximately 30 spicules of each type).

Mycale (*A.*) *magellanica* was found at new locations along the Argentine shelf-break, these new records extend the distribution of this species northwards (sample Nº5, 38º36.02'S and 55º44.68'W, 91 m) (Table 1, Fig. 1).

Six sponge pieces were dissected (wet weight: 369, 555, 338, 660, 417 and 355 g) and a total of 849 endobiont individuals were sorted (Table 2). Considering water displacement measures, in general 1 g of sponge corresponds to a volume of ~1 ml (in all six pieces measured). Hence, on average, the sponge *M.* (*A.*) *magellanica* had a mean density of ~348 individuals per litre (or kilogram). Twenty three taxa grouped into five major groups (Crustacea, Mollusca, Echinodermata, Polychaeta, and Sipunculida) were identified. Crustaceans, mainly Amphipoda and Isopoda, reached between 66% and 96% of the total number of individuals inhabiting the sponges. The most frequent and abundant species were the amphipod *Aristias* cf. *antarcticus* Walker, 1906 and the isopod *Caecognathia*

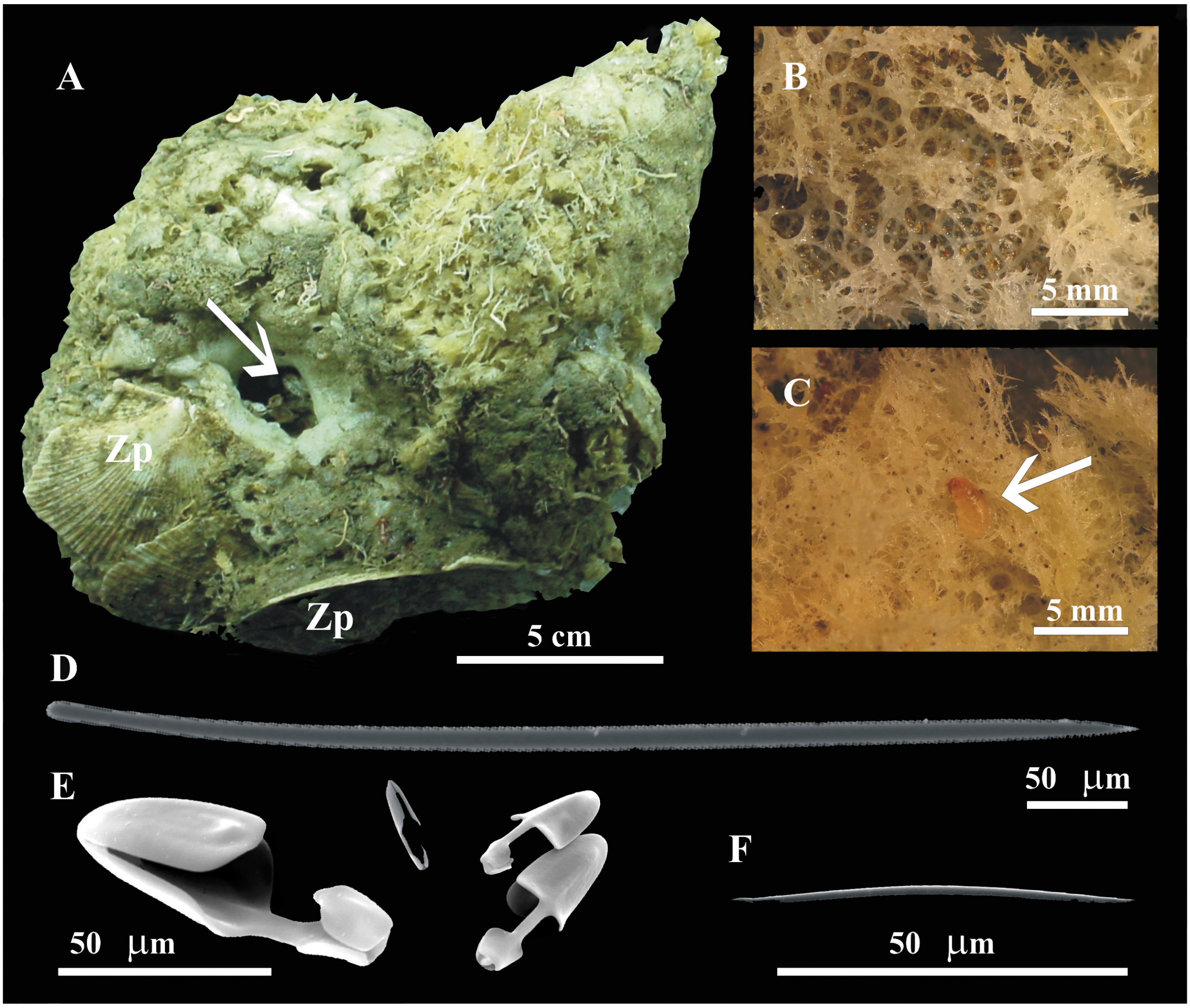

Fig. 2. – *Mycale* (*A.*) *magellanica* (Ridley, 1881). A, macroscopic view of one specimen; Zp, *Zygochlamys patagonica* old shells; arrow shows individuals of *Hiatella meridionalis* bysally attached in a depression of the sponge. B, C, internal structures of *M.* (*A.*) *magellanica*; arrow shows a specimen of *Aristias* cf. *antarcticus*. Spiculation (SEM images): D, mycalostiles; E, anisochelae; F, microxea.

sp. For both species, adult males, brooding females and juveniles were found. Four other species of amphipods and three of isopods were recorded in lower abundance (Table 2).

The structure, morphology and internal architecture of *M.* (*A.*) *magellanica* were very heterogeneous in each single piece (see Fig. 2B, C). Usually the basal part was compact and intricate, and no endobionts were detected (except for a few bivalves identified as *Hiatella meridionalis* (d'Orbigny, 1846) and some ophiuroids). From the base to the surface, the sponge tissues displayed less dense and softer structures that hosted the majority of the amphipods, isopods and other faunal components (Fig. 2D). Living *H. meridionalis* were found in holes, depressions or crevices of the sponge. However, a few empty shells were also recorded completely embedded inside sponge tissues.

Other endobiotic organisms recorded were the echinoderms *Ophiactis asperula* (Philippi, 1858), *Ophiura lymani* (Ljungman, 1871), *Ophiacantha vivipara* Ljungman, 1870 and *Pseudocnus dubiosus* (Semper, 1868); polychaetes of at least three families (Spionidae, Polynoidae, Phyllodocidae); and the decapod *Nauticaris magellanica* (A. Milne Edwars, 1891). Among them, ophiuroids were the most common (Table 2). Polychaetes were poorly preserved due to the freezing/melting process, so their main morphological features for specific identification were damaged.

DISCUSSION

This study is the first attempt to elucidate the composition of endofauna (excluding bacterial or fungal symbionts) in sponges from the deep waters of the Argentine Sea. In this regard, it is important to mention

Table 2. – Taxa and number of individuals associated with *Mycale* (*Aegogropila*) *magellanica* (Ridley, 1881) in the studied frozen samples. Location for each sample is given in Table 1. (A) Amphipoda, (I) Isopoda, (D) Decapoda, (O) Ophiuroidea, (H) Holothuroidea.

Taxa / Sample N°	11	12	13	14	15	16
Crustacea						
Aristias cf. *antarcticus* (A)	163	153	152	12	9	18
Leucothoe cf. *spinicarpa* (A)				7	6	9
Seba cf. *saundersii* (A)	25	18	23		3	5
Colomastix bastidai (A)				7		
Liljeborgia sp. (A)				1		
Caecognathia sp. (I)		2		37	1	61
Fissarcturus patagonicus (I)	2					
Acanthoserolis schythei (I)		1				
Iathrippa sp. (I)	1	1	1			
Nauticaris magellanica (D)	1					
Mollusca						
Hiatella meridionalis	1		2	1	9	15
Bivalvia unidentified				1		
Gastropoda unidentified						1
Echinodermata						
Ophiactis asperula (O)	20	7	20	1		8
Ophiacantha vivipara (O)	9	3	2			
Ophiura lymani (O)		3	1			
Pseudocnus dubiosus (H)	2	3	3	1		
Polychaeta						
Spionidae	2	2	2			
Polynoidae	1	1				1
Phyllodocidae			1			
Polychaeta unidentified 1		1				1
Polychaeta unidentified 2		3				
Sipunculida						
Sipunculida unidentified						1
Others						
Unidentified egg capsules					1	
Total	227	198	207	68	29	120
Wet Weight (g)	338	369	555	660	417	355
Density (per litre)	671.6	536.6	372.9	103.0	69.5	338.0

that the species *Mycale* (*Aegogropila*) *magellanica* has been previously recorded in the Argentine Sea, mainly in South Patagonian waters, around the Malvinas Islands with scattered records from the Beagle channel and coastal waters of the provinces of Tierra del Fuego and Chubut. Until now, there was only one record from waters off Buenos Aires province (see López Gappa and Landoni 2005). Our results extend the distribution of this species northwards in the SW Atlantic Ocean (Fig. 1).

Mycale (*A.*) *magellanica* seems to be important in providing habitat for at least 23 taxa of small invertebrates. Crustaceans were the most important group in abundance and diversity in this study. It is noticeable from the general literature that, among amphipods, members of the Aristiidae, Colomastigidae, Leucothoidae and Sebidae are known to be frequent endobionts of sponges and other sessile invertebrates (LeCroy 2009, Thomas and Klebba 2007, Winfield *et al.* 2008, White and Thomas 2009, Winfield and Ortiz 2010, Kilgallen 2010, and references therein). However, the species collected in the present study had not been previously recorded inside sponges in the Argentine Sea (see López Gappa *et al.* 2006, De Broyer *et al.* 2007).

Until this study, *Colomastix bastidai* Alonso de Pina, 1993 was only known from the type locality, a position adjacent to the new records mentioned herein (see López Gappa *et al.* 2006, Table 3). Our finding of *C. bastidai* represents the second record of the species in Argentine waters. *Leucothoe spinicarpa* (Abildgaard, 1789) has been reported from polar, temperate, and tropical waters (Thiel 2000). In the Argentine Sea, several records of *L. spinicarpa* have been reported, many of them in the Magellanic Biogeographic Region and only one in the Argentine Biogeographic Region (see López Gappa *et al.* 2006). However, according to De Broyer *et al.* (2007), the Southern Ocean records of *L. spinicarpa* probably belong to one or more southern species. Because of the need for a revision of this species and in order to avoid more taxonomic confusion, we prefer to keep the denomination of *Leucothoe* cf. *spinicarpa.* Similarly, *Aristias antarcticus* Walker, 1906 has been cited from the Malvinas Islands in the Argentine Sea, and it is also widely distributed in Antarctic and sub-Antarctic waters (López Gappa *et al.* 2006, De Broyer *et al.* 2007). The systematics of the southern *Aristias* spp. is in disarray and all previous records of *A. antarcticus* require confirmation (Kilgallen 2010). Therefore, we also keep the denomination of *Aristias* cf. *antarcticus*. Because of the wide geographic distribution of *Seba saundersii* Stebbing, 1875 (in the southern Argentine Sea, sub-Antarctic and Antarctic waters) and the poorly preserved condition of the specimens examined, we identified them as *Seba* cf. *saundersii*. For both genera, *Aristias* and *Seba*, the new records presented herein are the northernmost known in the Argentine Sea (see López Gappa *et al.* 2006).

Among the isopods, the second most important group of endobiont crustaceans found, the species *Caecognathia* sp. (Gnathiidae), was recorded in high abundances. *Caecognathia antarctica* (Studer, 1884) is the only species of gnathiid isopod reported from the Argentine Sea. The specimens found in our samples most probably belong to this species; however, since Studer (1884) briefly described *C. antarctica* based on a single juvenile, it is not possible to identify this species with certainty. The life cycle of gnathiid isopods involves a parasitic larval phase and a non-feeding adult phase (Monod 1926). The resting larvae and the adult stages are usually found in sponges, tubes of serpulid worms, coral rubble or sediment cavities (Monod 1926, Upton 1987, Wägele 1988, Klitgaard 1997, Smit and Davies 2004). Almost all the specimens of *Caecognathia* sp. obtained in our samples were males. The lower abundance of females in sponges was also reported by Smit *et al.* (2003) and Barnard (1914); the latter author found the females inhabiting the tubes of serpulid worms. Three other species of isopods were found in the studied sponge, *Fissarcturus patagonicus* (Ohlin, 1901), *Acanthoserolis schythei* (Lütken, 1858) and *Iathrippa* sp., but each species was represented by one or two individuals. Klitgaard (1995) pointed out that owing to sampling procedures, contamination of the sponge with foreign fauna could be expected. Since these three isopod species were recorded in very low densities and none of them were reported as sponge associates, the finding of these species on *M.* (*A.*) *magellanica* can be considered accidental.

The finding of juvenile stages and brooding females of *Aristias* cf. *antarcticus* and *Caecognathia* sp., although in low abundances, shows that at least a couple of species have a close relationship with *M.* (*A.*) *magellanica*, and part of their life cycles probably takes place inside the sponge, as is already known for gnathiids.

In the study area, where the main Patagonian scallop (*Zygochlamys patagonica*) fishing grounds are located (the shelf-break frontal area), general knowledge on the biodiversity of the small-sized taxa is very scarce. The species composition of this benthic fraction (bigger than 1 mm) was recently assessed by means of samples taken with Picard dredge (Sánchez *et al.* 2011). In coincidence with our results, these authors also found that crustaceans were the most diversified group. The biological material studied by these authors and our present samples come from nearby locations. Only the genus *Iathrippa* (Isopoda, Asellota, Janiridae) is common to both habitats, although its finding in *M.*(*A.*) *magellanica* could be incidental. Nonetheless, many other crustaceans (especially Lysianassidae spp.) and polychaetes were identified to family level by Sánchez *et al.* (2011), which could indicate a higher species overlapping between the two studies.

The molluscs and echinoderms species identified herein (see Table 2) are conspicuous components of the Patagonian scallop epibenthic assemblage (Bremec and Lasta 2002, Bremec *et al.* 2003, Schejter *et al.* 2008). *Hiatella meridionalis* (d'Orbigny, 1846) (largely misidentified as *H. solida* (Sowerby, 1834) (see Simone and Penchaszadeh 2008)) is a common bivalve found attached to either rocks or invertebrates, including *Z. patagonica* (Schejter and Bremec 2007a). In the SW Atlantic, similar records were found in Brazilian waters: *H. arctica* Linnaeus, 1767 was mentioned as an endobiont in *Mycale* (*Zygomycale*) *angulosa* (Duchassaing and Michelotti, 1864) (as *Zygomycale parishii*) and *Mycale* (*Carmia*) *microsigmatosa* Arndt, 1927, at nearly 23°S (Duarte and Nalesso 1996, Ribeiro *et al.* 2003). Regarding echinoderms, the genus *Ophiactis* and the species *Ophiura lymani* are shared between Brazilian and Argentine *Mycale* species; *Ophiactis savignyi* (Müller and Troschel, 1842) and *Ophiura lymani* Ljungman, 1871 were present in Brazilian sponge species, and even dominant in *M.* (*Z.*) *angulosa* (Duarte and Nalesso 1996). Although the reduction in predation pressure is granted by chemically protected hosts such as sponges (Majer *et al.* 2009), which give a favourable habitat to shelter ophiuroid species (Neves *et al.* 2007), they were not numerically dominant in our samples.

Other infaunal groups that also appeared in low abundance in the studied sponges were polychaetes and sipunculids (only six taxa, see Table 2). Polychaetes are usually one of the dominant groups in sponges (see Supplementary material Appendix 1). A clear relationship between faunal densities and sponge morphology was established by comparing many studies and, for example, in the case of a syllid species, it was reported that lobate sponge species are able to grow faster than massive ones, supporting higher densities of worms (Neves and Omena 2003). Considering the endofauna hosted by other *Mycale* species (Duarte and Nalesso 1996, Ribeiro *et al.* 2003, Table 1), in which polychaetes were the dominant group in one of the species but crustaceans were dominant in the other one, it remains unclear whether the morphology or internal architecture of *M.* (*A.*) *magellanica* could be responsible for hosting only low densities of polychaetes but high densities of crustaceans.

In general, the highest endobiont richness was found in sponges at low depths and low latitudes (warmest waters) (Supplementary material Appendix 1). The highest endobiont richness could be found in *Aplysina aerophoba* Nardo, 1883, *Sarcotragus fasciculatus* (Pallas, 1766) and *Agelas oroides* (Schmidt, 1864) from the Aegean Sea, with more than 100 associated species each. Considering only the *Mycale* genus, our species showed the lowest endobiont richness, in accordance with the highest latitude and depth.

The shelf-break frontal area in the Argentine Sea is one of the most productive ecosystems in the SW Atlantic Ocean (Acha *et al.* 2004, Bogazzi *et al.* 2005) as a consequence of high levels of nutrients (Rivas 2006, Romero *et al.* 2006). This region is dominated by soft-bottoms (sand and mud), like more than 70% of the Argentinean continental shelf (Parker *et al.* 1997). In these habitats, epibiotic relationships are known to increase the specific diversity by providing substrate for the attachment of sessile species, given the lack of rocks or hard bottoms (Schejter and Bremec 2007a, Schejter *et al.* 2011). Our study thus shows that the sponges themselves also enhance benthic biodiversity, as they are able to shelter a variety of invertebrate species. The endobiont richness is a valuable contribution to local biodiversity, though the values found in *M.* (*A.*) *magellanica* are smaller than those shown by other more tropical sponge species.

In soft and flat substrates, erect and sessile epifauna usually play the role of ecosystem engineers, as they structure the architecture of the sea bottom by increasing its complexity. Mass removal of this fauna could have devastating effects on local biodiversity (Coleman and Williams 2002, Abdo 2007). Trawling and dredging activities are the main causes of loss of erect and sessile epifauna (National Research Council 2002, Bremec *et al.* 2000, 2008). Therefore, fishing activities on the Patagonian scallops beds could affect the settlement of *M.* (*A.*) *magellanica*, thus leading to the loss of associated endobionts.

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SUPPLEMENTARY MATERIAL

The following Appendix is available through the web page
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Appendix 1. – Endobiotic fauna of Porifera from several regions, considering the morphology of the sponge, bathymetric distribution, latitude, richness and dominant taxon group. Fishes and microbial symbionts were not considered. (1) The reference to the endobionts of this species does not provide a description of the general morphology. (2) The reference to the endobionts of this species does not provide a description of the general morphology, which is provided from another source in brackets.

Mycale (Aegogropila) magellanica (Porifera: Demospongiae) in the southwestern Atlantic Ocean: endobiotic fauna and new distributional information

LAURA SCHEJTER, IGNACIO L. CHIESA, BRENDA L. DOTI and CLAUDIA BREMEC

Supplementary material

APPENDIX 1. – Endobiotic fauna of Porifera from several regions, considering the morphology of the sponge, bathymetric distribution, latitude, richness and dominant taxon group. Fishes and microbial symbionts were not considered. (1) The reference to the endobionts of this species does not provide a description of the general morphology. (2) The reference to the endobionts of this species does not provide a description of the general morphology, which is provided from another source in brackets.

Species	Morphology	Location	Depth (m)	N° associated species (habits)	Dominant taxa	Source
Agelas clatrodes (Schmidt, 1870)	Massive	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Agelas dispar Duchassaing and Michelotti, 1864	Massive	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Agelas oroides (Schmidt, 1864)	(1)	N Aegean Sea (40°N)	3-6	61	Polychaeta (32 taxa)	Koukouras *et al.* (1985)
	Massive, lobate	N Aegean Sea (40°N)	15-20	135 (mainly endobionts)	Unavailable	Koukouras *et al.* (1996)
Aiolochroia crassa (Hyatt, 1875)	Lobate	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Amphimedon compressa (Duchassaing and Michelotti, 1864) as *Haliclona rubens*	(1)	Caribbean Sea (Bimini Is.)	1-2	11	Crustacea (6 taxa)	Pearse (1950)
Amphimedon compressa (Duchassaing and Michelotti, 1864)	Lobate	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Amphimedon viridis Duchassaing and Michelotti, 1864	(1)	Gulf of Mexico (Florida, 29ºN)	1-2	10 (endobionts and epibionts)	Crustacea (7 taxa)	Huang *et al.* (2008)
	Lobate	SW Atlantic (Rocas Atoll, 3°S	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Aplysina aerophoba Nardo, 1833	Digitated	N Aegean Sea (40°N)	3-6	104	Crustacea (39 taxa)	Koukouras *et al.* (1985)
as *Verongia aerophoba*	(1)	N Aegean Sea (40°N)	15-20	184 (mainly endobionts)	No data	Koukouras *et al.* (1996)
Aplysina sp.	Lobate	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Axinella cannabina (Esper, 1794)	Erect, irregularly branched	N Aegean Sea (40°N)	15-20	84 (mainly endobionts)	No data	Koukouras *et al.* (1996)
Axinella infundibuliformis (Linnaeus, 1759) as *Tragosia infundibuliformis*	Elastic, foliaceous or funnel-shaped	NE Atlantic (Faroe Islands, 62°N)	157-780	15 (mostly epifauna)	Polychaeta (5 taxa)	Klitgaard (1995)
Axinella polycapella de Laubenfels, 1953	Slightly upright, few short branches	NW Atlantic, 31ºN	58-66	19	Crustacea (14 taxa)	Kjellin Green (2008)
Axinella rugosa (Bowerbank, 1866) as Phakellia rugosa	Elastic, ramified	NE Atlantic (Faroe Islands, 62°N)	157-780	28 (mostly epifauna)	Ophiuroidea (6 taxa)	Klitgaard (1995)
Clathria (*Clathria*) *prolifera* (Ellis and Solander, 1786) as *Microciona prolifera*	Erect, branching and bushy	NW Atlantic, Washington	Subtidal	52	Crustacea	Long (1968)
Clathria (*Thalysias*) *schoemus* (de Laubenfels, 1936) as *Aulospongus schoemus*	Branching	Caribbean Sea (Bimini Is.)	1-2	3	Polychaeta (2 taxa)	Pearse (1950)
Geodia barretti Bowerbank, 1858	Solid, massive	NE Atlantic (Faroe Islands, 62°N)	157-780	8 (mostly epifauna)	Polychaeta (3 taxa)	Klitgaard (1995)

Species	Morphology	Location	Depth (m)	N° associated species (habits)	Dominant taxa	Source
Geodia cydonium (Jameson, 1811)	(2) Solid, globular (from Johnston 1842)	Aegean Sea (40°N)	3-6	98	Crustacea (40 taxa)	Koukouras *et al.* (1985)
Geodia macandrewii Bowerbank, 1858	Solid, massive	NE Atlantic (Faroe Islands, 62°N)	157-780	57 (mostly epifauna)	Polychaeta (21 taxa)	Klitgaard (1995)
Geodia sp.	Solid, massive	NE Atlantic (Faroe Islands, 62°N)	157-780	23 (mostly epifauna)	Polychaeta (6 taxa)	Klitgaard (1995)
Halichondria panicea (Pallas, 1966)	Encrusting	NW Atlantic	Intertidal	68	Crustacea	Long (1968)
Haliclona sp.1	Amorphous, chimney-like oscules	SW Australia (30-40°S)	10-15	23 (endobionts)	Crustacea (15 taxa)	Abdo (2007)
Haliclona sp.2	Mound-shaped, compact	SW Australia (30-40°S)	10-15	23 (endobionts)	Crustacea (15 taxa)	Abdo (2007)
Hippospongia communis (Lamarck, 1814)	(2) Massive, compact, and usually roughly spherical (from Cook and Bergquist 2002a)	Mediterranean, Tunisia	14	24	Crustacea (11 taxa)	Rützler (1976)
Hymeniacidon sanguinea (Grant, 1827) sensu Burton, 1840 (currently, this species needs revision)	Encrusting	SW Atlantic (Mar del Plata, 38°S)	Intertidal ponds	33 (endobionts and epibionts)	Crustacea (12 taxa)	Cuartas and Excoffon (1993)
Ircinia felix (Duchassaing and Michelotti, 1864)	Lobate	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	no data	Polychaeta (16 taxa)	Neves and Omena (2003)
		NO Atlantic, 31ºN	58-66	84	Crustacea (31 taxa)	Kjellin Green (2008)
Ircinia oros (Schmidt, 1864) (from the original description)	(2) Massive, rounded	Mediterranean, Tunisia	14	6	Polychaeta	Rützler (1976)
Ircinia retidermata Pulitzer-Finali and Pronzato, 1981	Hemispherical	E Mediterranean	830	4	Polychaeta (3 taxa)	Ilan *et al.* (1994)
Ircinia strobillina (Lamarck, 1816) as *Hiricina strobilina*	Solid, firm (loggerhead)	Caribbean Sea (Bimini Is.)	1-2	30	Polychaeta (11 taxa)	Pearse (1950)
Ircinia variabilis (Schmidt, 1864)	(2) Variable, massive or thickly encrusting (from the original description)	Mediterranean, Tunisia	14	16	Crustacea (8 taxa)	Rützler (1976)
Iotrochota birotulata (Higgin, 1877) as *Iotrochota brotulata*	Branching	Caribbean Sea (Bimini Is.)	1-2	4	Crustacea (2 taxa)	Pearse (1950)
Isops phlegraei Sollas, 1880	Solid, massive	NE Atlantic (Faroe Islands, 62°N)	157-780	44 (mostly epifauna)	Bryozoa (11 taxa)	Klitgaard (1995)
Mycale (*Z.*) *angulosa* (Duchassaing and Michelotti, 1864) as *Zygomycale parishi*	Globose to fistulous	SW Atlantic (Sao Paulo, 23°S)	Subtidal	98	Polychaeta (39 taxa)	Duarte and Nalesso (1996)
Mycale (*A.*) *magellanica* (Ridley, 1881)	Massive	SW Atlantic, Argentina	103-107	23 (mostly endobionts)	Crustacea (10 taxa)	Present study

Species	Morphology	Location	Depth (m)	N° associated species (habits)	Dominant taxa	Source
Mycale (*C.*) *microsigmatosa* Arndt, 1927	Encrusting, can be massive	SW Atlantic (Rio de Janeiro, 23°S)	1-5	75 (endobionts and epibionts)	Crustacea (31 taxa)	Ribeiro *et al.* (2003)
Mycale (*A.*) *syrinx* (Schmidt, 1862)	(2) Erect, branched (from Lévi 1960)	N Aegean Sea	Not given	No data	Crustacea (6 taxa)	Voultsiadou-Koukoura and Koukouras (1993)
Paraleucilla magna Klatau, Monteiro and Borojevic 2004	(2) Massive (from the original description)	SW Atlantic (Rio de Janeiro, 23°S)	Harbour areas	48	Crustacea (11 taxa)	Padua *et al*. (2010)
Petrosia ficiformis (Poiret, 1789)	(2) Variable; usually spherical and cylindrical (from Bavestrelo and Sara 1992)	N Aegean Sea (40°N)	3-6	91	Crustacea (43 taxa)	Koukouras *et al.* (1985)
Phakellia robusta Bowerbank, 1866	Elastic, foliaceous or funnel-shaped	NE Atlantic (Faroe Islands, 62°N)	157-780	42 (mostly epifauna)	Bryozoa (13 taxa)	Klitgaard (1995)
Phakellia ventilabrum (Linnaeus, 1767)	Elastic, foliaceous or funnel-shaped	NE Atlantic (Faroe Islands, 62°N)	157-780	22 (mostly epifauna)	Bryozoa (7 taxa)	Klitgaard (1995)
Plakortis sp.	Encrusting	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)
Plakortis sp.	Massive	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	no data	Polychaeta (16 taxa)	Neves and Omena (2003)
Ptilocaulis walpersi (Duchassaing and Michelotti, 1864)	Upright, branched	NW Atlantic, 31ºN	58-66	60	Crustacea (23 taxa)	Kjellin Green (2008)
Sarcotragus fasciculatus (Pallas, 1766) as *Ircinia fasciculata*	(2) Massive, irregular, and encrusting; usually	N Aegean Sea (40°N)	3-6	151	Polychaeta (61 taxa)	Koukouras *et al*. (1985)
as *I. fasciculata*	upright and digitate (from Cook and Bergquist 2002b)	Mediterranean, Tunisia	14	13	Crustacea (7 taxa)	Rützler (1976)
Sarcotragus foetidus (Schmidt, 1862) as *Ircinia muscarum*	(1)	N Aegean Sea (40°N)	3-6	90	Polychaeta and Crustacea (37 taxa each)	Koukouras *et al.* (1985)
as *I. muscarum*		Mediterranean, Tunisia	14	14	Crustacea (10 taxa)	Rützler (1976)
as *Sarcotragus muscarum*	Massive, globular	E Mediterranean	830	4	Polychaeta (4 taxa)	Ilan *et al.* (1994)
Spheciospongia vesparium (Lamarck, 1815) as *Spheciospongia vesparia*	Solid, firm, hemispherical to barrel-shaped (loggerhead)	Caribbean Sea (Bimini Is.)	1-2	9	Crustacea (9 taxa)	Pearse (1950)
		(Curacao and Bonaire Is.)	3-60	26	Crustacea (18 taxa)	Westinga and Hoetjes (1981)
Spongia officinalis Linnaeus, 1759	(2) Variable, usually massive spherical, lamellate, caliculate, or low and spreading (from Cook and Bergquist 2002a)	N Aegean Sea (40°N)	3-6	89	Polychaeta (36 taxa)	Koukouras *et al.* (1985)

Species	Morphology	Location	Depth (m)	N° associated species (habits)	Dominant taxa	Source
Spongia zimocca Schmidt, 1862	(2) Variable, massive, generally irregularly lobate (from Castritsi-Catharios *et al*. 2001)	Mediterranean, Tunisia	14	13	Crustacea (6 taxa)	Rützler (1976)
Stryphnus ponderosus (Bowerbank, 1866)	Solid, massive	NE Atlantic (Faroe Islands, 62°N)	157-780	122 (mostly epifauna)	Polychaeta (35 taxa)	Klitgaard (1995)
Suberites latus Lambe, 1893 as *S. lata*	Massive, tough	NW Atlantic	5-10	25	Polychaeta	Long (1968)
Thenea levis Lendenfeld, 1907	Solid, elongate	NE Atlantic (Faroe Islands, 62°N)	157-780	108 (mostly epifauna)	Polychaeta (38 taxa)	Klitgaard (1995)
Thenea valdiviae Lendenfeld, 1907	Solid, spherical or lump-formed	NE Atlantic (Faroe Islands, 62°N)	157-780	90 (mostly epifauna)	Polychaeta (41 taxa)	Klitgaard (1995)
Topsentia ophiraphidites (de Laubenfels, 1934)	Massive	SW Atlantic (Rocas Atoll, 3°S)	Intertidal pools and semi-enclosed lagoon	No data	Polychaeta (16 taxa)	Neves and Omena (2003)